and other conditions rendering it relatively somewhat inaccessible; and the quarter of a terrestrial meridian was finally adopted. It is pleasing to note that throughout the discussion which led to this result, the influential members of the Commission, as well as many others not members, stood out against the use of any unit of length or mass already in use in France, as it was recognized that such use would be an obstacle to the introduction of the system among the people of other nations. An interesting episode of the initiative of the arc measurement was a controversy over the use of a sector in the determination of latitude or the newly invented repeating circle of Borda. Indeed it seems not unlikely that 'a desire to make the reputation of the circle of Borda' had some influence in the choice of the new standard as against the seconds pendulum. Delambre proposed to Borda to employ both sector and circle, but the latter dryly intimated that it was desired to ascertain if the sectors were good, and the matter was not pressed.

When the Commission was received by the King, Louis XVI., after its recommendations had been approved and before the formal beginning of its operations, his majesty, speaking to each one in turn of the special duties that had been assigned to him, asked Cassini (the fourth eminent astronomer bearing that name), to whom had been assigned the triangulation and measurement of latitudes, how it was that he was going to remeasure an arc of the meridian that his father and grandfather had already done before him. Did he hope to do better than they? To which Cassini replied that he would not so flatter himself, if he had not a great advantage over them in the fact that while the instruments which they used in measuring angles gave results correct to within fifteen seconds, that invented by Borda would enable him to reach a precision of one second.

M. Bigourdan's volume contains much detailed information relating to the work of the Commissions, with many interesting and important citations from original documents. The fundamental legislation by which the system was founded is fully discussed, the opposition to it is fairly presented, and the subsequent legislation and discussion leading to its final adoption by the nation as a whole receive satisfactory treatment. There is a chapter on the propagation of the system among foreign nations which leads up to the appointment of an international metric commission about 1870, and to the establishment of the International Bureau of Weights and Measures about 1875. The splendid work of the latter during the twenty-five years of its activity is treated in some detail and forms a fitting close to a most useful and interesting contribution to the history of metrology.

T. C. MENDENHALL.

A Treatise on Electromagnetic Phenomena and on the Compass and its Deviations Aboard Ship, Mathematical, Theoretical and Practical. By Commander T. A. LYONS, U. S. Navy. John Wiley & Sons.

The first volume of this treatise, the only one yet published, deals with electromagnetic phenomena, or radiation in all its protean forms. If the reader wants information about sun-spots or auroræ, about Crookes's fourth state of matter or Bjerknes's imitations of magnetic fields by pulsating discs, about the work of Hertz or the genesis and action of Röntgen rays, he will find it in this introductory volume. However many and however diverse the subjects discussed, they are all treated from the point of view of the wave-theory. Commander Lyons seems to hold a brief for the ether whose existence he seeks to remove from the condition of a working hypothesis and whose properties he tries very hard to define. This is indeed a difficult task; for he tells us, on page 9, that "the mathematician attributes to the ether properties necessary to the formation of equations expressing its energy; the physicist ascribes to it qualities essential to the explanation of facts; the electrician meets conditions that require further hypotheses; still others do not accept fully any one of these conceptions; and some even reject the ether altogether."

So conscious is the author of the paramount importance in physics and philosophical speculation of the medium which fills intermolecular as well as interstellar space, that he dwells with great insistence upon the experimental evidence which there is for its existence. He is so eager

to beget in the mind of the reader the strong etheric conviction of his own, that he does not hesitate to recall and repeat where such repetition seems to him necessary. It must be admitted that he has made out a very commendable case for the medium as well as for its magnetic, electric and luminous properties.

The book reads easily. The style is not severely didactic; it is clear, sometimes diffuse and occasionally rhetorical. Here and there we meet similes and metaphors that occasion surprise, partly by their unexpectedness and partly by their novelty or boldness. Thus we are told that when electromagnetic waves reach the more tenuous strata of our atmosphere, they illumine them, and as a consequence "we have those brilliant auroras that cap the magnetic poles like huge candle-extinguishers" (!) (p. 20). Again, "magnetic storms have overspread the continents of Europe and America at the same time, when every needle was affected as with a kind of frenzy—oscillating together, as if some gigantic Briareus reached out his hundred arms, and with a finger on every one moved them regularly or wildly as the mood was upon him" (p. 6). On page 41 we find 'a *mote* of ether' and on page 62 we are confronted with 'a *jungle* of electromagnetic manifestations.'

The following passage, which occurs on page 197, is quite Tyndallian:

> From ships of war cruising in every sea; from merchant vessels plying between the ports of the world; from observatories equipped with delicate instruments in various countries; from expeditions afloat and ashore specially fitted out for the purpose; and from numerous other private and public sources of many kinds—have been gathered, during long years, a multitude of observations of the magnetic elements; collated, classified and stripped of all discernible errors, they afford, when plotted on charts of the globe, an excellent insight into its magnetic condition.

We can hardly, however, bring ourselves to define the dyne as 'the unit of measure of magnetic intensity' (page 434), for we have hitherto accepted it as the unit of force. On the same page we read that "the weight of a body is the product of its mass by the force of gravity; the mass is everywhere a constant but hazy (!) factor, while gravity varies slightly from place to place, but is always accurately known. This being understood, the weight of a body will be spoken of as representing it." Adopting a word from this sentence, we cannot but qualify the above statement as somewhat 'hazy.' What we do know, and know clearly, is that the weight of a lump of matter depends conjointly on its mass and on the intensity of gravity, so that we can write

$$w = \lambda mg.$$

By a suitable choice of units, we can make $\lambda = 1$, and then we have

$$w = mg.$$

After stating that the mass of a body is constant, the writer might have said, in so many words, that its weight depends upon its position with respect to the center of the earth, and thence concluded that the important property of a body, both scientifically and commercially, is not its weight but its mass.

Ampère's theory of magnets is found on page 490 to be 'more rational than the theory of magnetized particles.' We should like to believe it, and consequently regret that the author did not give a few reasons in support of this opinion. The origin of the Ampèrian currents is no better known than that of the magnetization of the molecules in Weber's molecular theory, while the maintenance of the currents implies the further difficulty of a resistanceless circuit.

The author is very chary in the use which he makes of proper names. Doppler, it is true, gets credit on page 320 for his 'principle,' and Lissajous on page 52 for his 'figures.' Why not Lenz for his 'law' (page 410) and Zeeman for his 'effect' (page 503)? Peter the Pilgrim (Peregrinus) is mentioned *cum laude*, but Gilbert is passed *sub silentio!* Yet it was Gilbert, the philosopher of Colchester, who first explained the behavior of the compass and the dipping needle by his grand discovery that the earth itself is a huge magnet: *Magnus magnes ipse est globus terrestris* are his words. Surely Commander Lyons has read *De Magnete* either in the original Latin or in Mr. Mottelay's translation; so that his neglect of Gilbert's transcendent merits is hard to explain.

The magnetical discoveries of Columbus are

clearly stated on page 206, where is ascribed to him the first explicit record of a change in the variation (declination). "While Columbus," writes the author, "may not hence be said to have *discovered* the variation, he must be credited with having been the first to make it known, as well as the first to discover a line of no-variation." The author might have added that this agonic line lay a little to the west of the island of Fayal, one of the Azores; and he might also have informed the reader that the variation of the compass was not generally accepted as a fact until the middle of the sixteenth century—Gilbert's time—being supposed to be due to the mechanical defects of the compass itself.

The explanation of the earth-couple acting on the compass needle, given on page 383, is rather involved. The matter would be greatly simplified by discussing the usual expression, viz., $Hml \sin \theta$ deduced from a diagram on page 295. We notice that the author here resolves H at right angles to the length of the magnet, still the force acting at each end of the needle parallel to the magnetic meridian is not H but Hm; and the arm of the couple is $l \sin \theta$ so that the twisting moment is $Hml \sin \theta$.

It is necessary, when studying the distribution of free magnetism in a bar magnet, by the method given on page 181, to point out that the bar must be so placed that the axis of the compass-needle when at rest will lie in the magnetic meridian, with its north-seeking pole pointing magnetic north.

We are told on page 152 that a small magnetized bar will place itself equatorially when suspended between the poles of a horse-shoe magnet of nearly equal strength. This surely is a *lapsus calami*, for the bar will set, not equatorially, but axially.

A very important feature of this treatise is to be found in the diagrams and illustrations distributed throughout every one of its twelve chapters. Many of them are original, and are excellent efforts at representing graphically some difficult points in what we may term the physics of the ether. Teachers and students alike will find them very useful.

The author's object in the first part of his treatise is to give such information about the principal phenomena of magnetism and correlated subjects as will prepare the way for an intelligent grasp of the matter to be discussed in the second volume; and in this he has well succeeded. The work is full of up-to-date information set forth in a clear and frequently impressive manner. It makes one eager for the appearance of the concluding volume, which will treat of such practical matters as the compass, the ship considered as a magnet, swinging the ship, compensation of the deviations and the mathematical theory of these deviations.

Part I. extends to 556 pages and contains 368 figures, the whole put forth in the publisher's well-known excellent style.

M. F. O'REILLY.

Animal Life: a First Book of Zoology. By DAVID STARR JORDAN and VERNON L. KELLOGG. New York, D. Appleton & Co. 12mo. Pp. 329; frontispiece and 180 plates and figures in the text. Cloth, $1.20.

This handy, beautifully printed and illustrated book is a distinct attempt to introduce to the reader the subject of zoology from the standpoint of the life of the animal rather than from the purely systematic or comparative anatomy side. It is a book to read and enjoy in the fields and woods or at home rather than a manual to study in the laboratory. Its scope is well stated in the general headings of its sixteen chapters: (I.) The Life of the Simplest Animals; (II.) The Life of the Slightly Complex Animals; (III.) The Multiplication of Animals and Sex; (IV.) Function and Structure; (V.) The Life Cycle; (VI.) The Primary Conditions of Animal Life; (VII.) The Crowd of Animals and the Struggle for Existence; (VIII.) Adaptations; (IX.) Animal Communities and Social Life; (X.) Commensalism and Symbiosis; (XI.) Parasitism and Degeneration; (XII.) Protective Resemblances and Mimicry; (XIII.) The Special Senses; (XIV.) Instinct and Reason; (XV.) Homes and Domestic Habits; (XVI.) Geographical Distribution of Animals. Following the text proper are a table of the systematic position of the animals mentioned, a glossary and finally an excellent index.

In the subject matter of the volume one can-